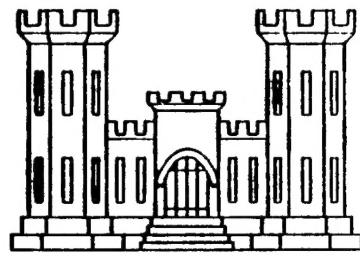


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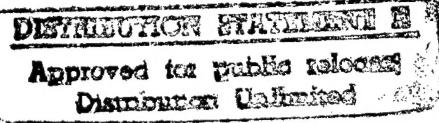
FINAL SUBMITTAL

ENERGY ENGINEERING ANALYSIS PROGRAM
FORT DRUM , NEW YORK



EXECUTIVE SUMMARY

INCREMENTS A, B, C, D, G, & F



PREPARED FOR:
NORFOLK DISTRICT CORPS OF ENGINEERS
NORFOLK , VIRGINIA
CONTRACT NO. DACA 65-84-C-0131

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CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS

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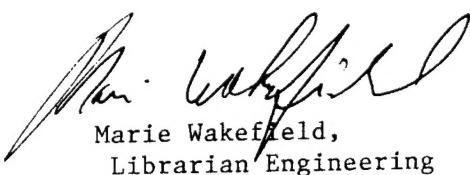
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EXECUTIVE SUMMARY

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1. EXECUTIVE SUMMARY

A. INTRODUCTION

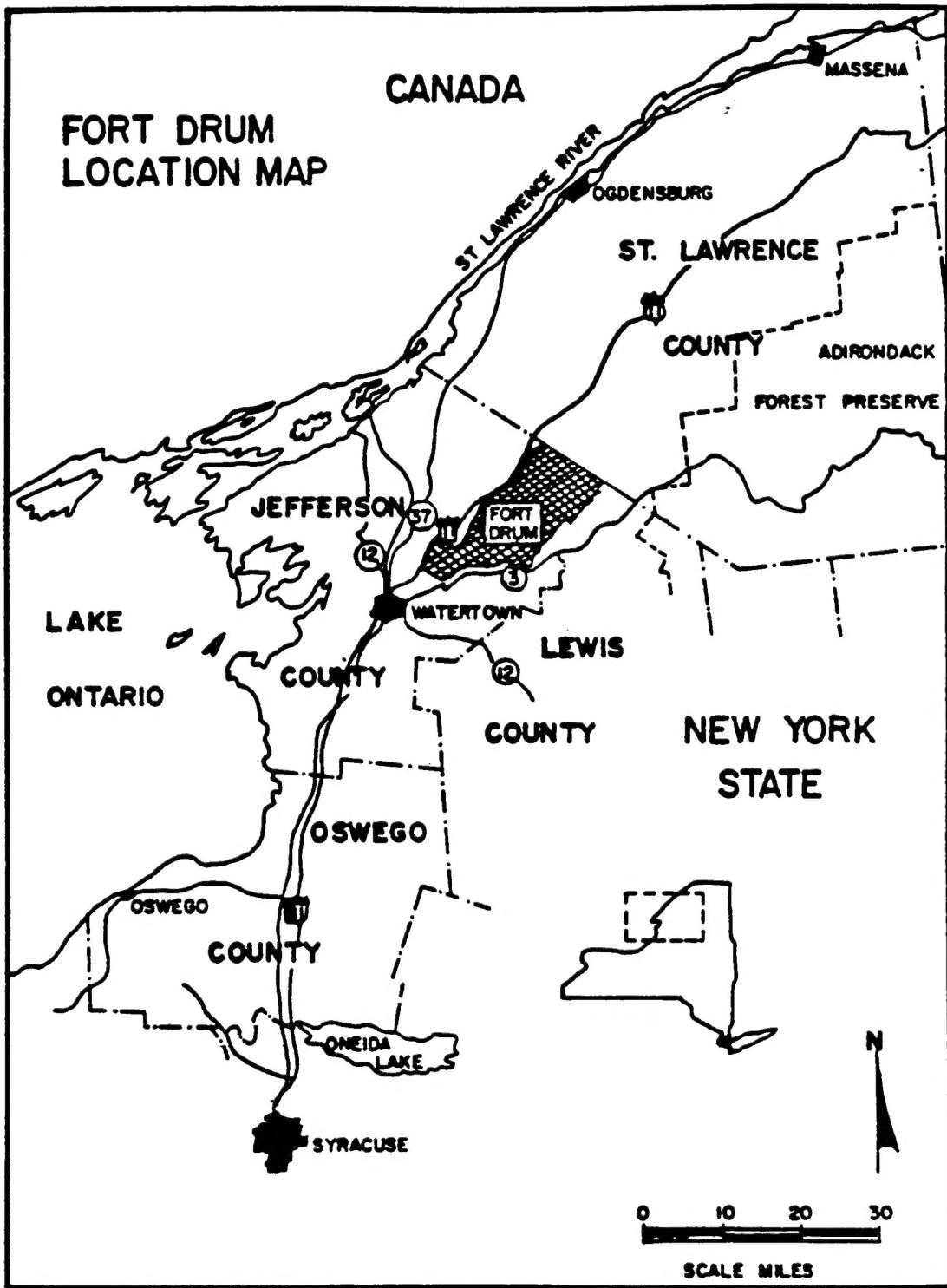
Fort Drum is located in northwestern New York approximatley 25 miles southeast of the United States-Canada border and 10 miles northeast of Watertown, New York. The region experiences very cold winters with heavy amounts of snowfall. Winter design temperature is -7 F. and the mean annual snowfall (recorded from 1925 to 1954) is 106.4 inches.

The principal operations at Fort Drum include training and other services to U.S. Armed Forces practicing combat skills and operations both on the land and in the air. Fort Drum's training program is unique in that a great deal of land area is available for manuevers. Also, the installation is the only military reservation in the 48 contiguous United States that possesses a suitable climate for the practice of combat troops under cold conditions. The present size of the installation is 107,265 acres and its primary mission is that of providing training facilities and services to U.S. Armed Forces requiring land and air space to practice combat skills and operations. Although used mainly by Army units, it also supports Marine, Naval, Air Force, and inter-service activities. Other missions are:

- o Support activities of other DOD tenant units
- o Commands all assigned or attached Army units
- o Support Reserve and National Guard training
- o Support Reserve Components in the event of mobilization.

The population of Fort Drum is composed of numerous groups and does vary on a yearly basis due to reserve and active forces winter training. Fort Drum has 1,143 buildings, of which 195 are occupied year-round. The majority of these buildings are of temporary construction and many are heated by hand-fired coal stoves. Equipment age and the lack of automatic controls often lead to inefficient operation of the hand-fired equipment. Family housing units are heated by baseboard electric resistance heaters and natural gas heating units. Some housing units have electric domestic water heaters. The housing units are not equipped with air-conditioning.

FORT DRUM LOCATION MAP



This EXECUTIVE SUMMARY provides a summarization of energy use and includes the results of five Increments of the ENERGY ENGINEERING ANALYSIS PROGRAM performed for Fort Drum.

B. EXISTING ENERGY CONSUMPTION

1 Basewide energy consumption FY 1978. Energy consumption in year FY 1978 is used as the "BASELINE" year instead of 1975. The Fort Drum DEH office indicated that the winter population and energy consumption of FY 1978 is more representative of the average than 1975.

a. FY 1978 Source Energy Consumption (from Black and Veatch Study dated 1981).

Total	=	545,245 btu x 10 ⁶
Electricity	=	207,193 btu x 10 ⁶
Fuel Oil	=	190,836 btu x 10 ⁶
Coal	=	119,954 btu x 10 ⁶
LPG	=	27,262 btu x 10 ⁶

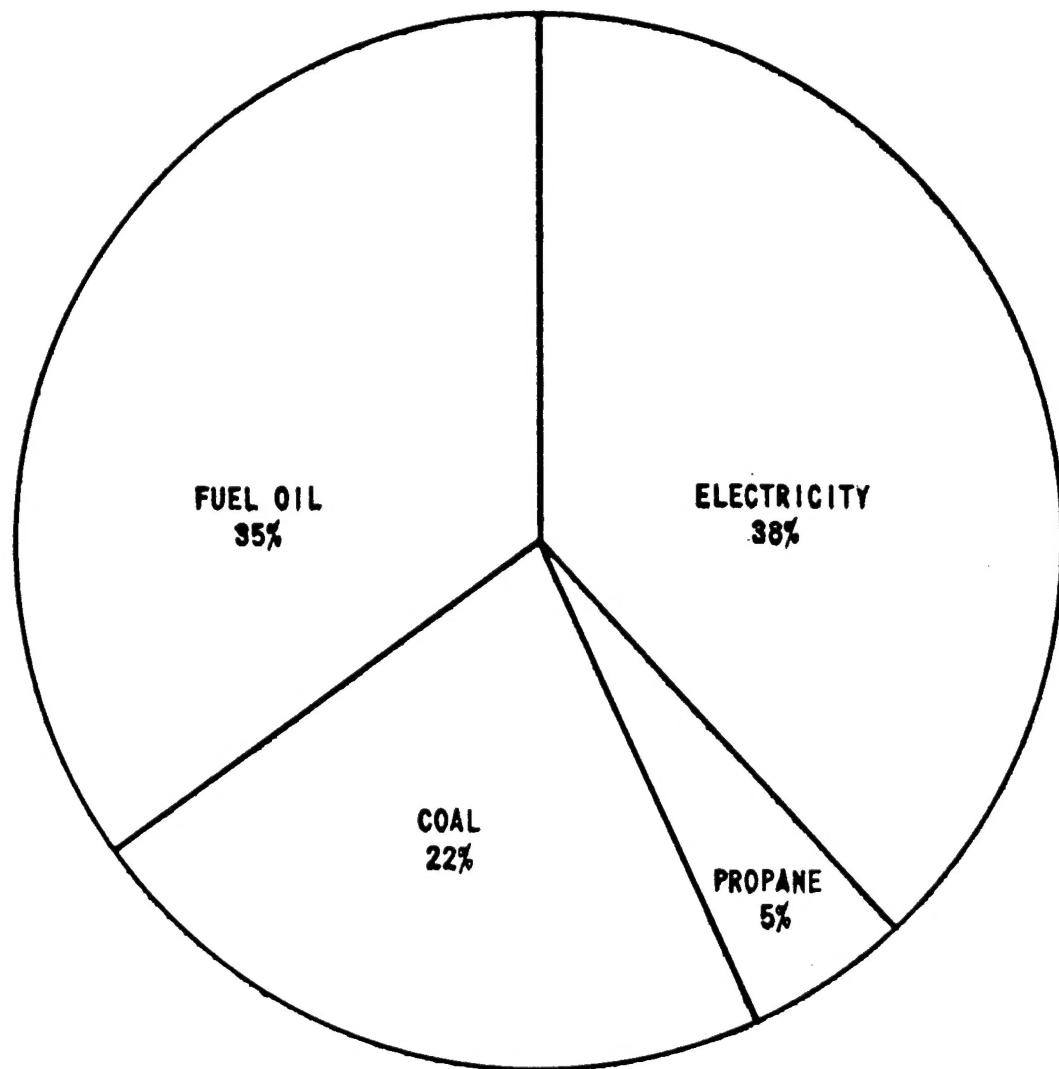
b. FY 1985 Source Energy Consumption (from DEH).

	<u>BTU x 10⁶</u>	<u>Cost</u>
Total	531,949	\$ 2,899,679
Electricity	320,024	1,537,213
Fuel Oil	147,983	1,060,342
Coal	31,749	87,500
Natural Gas	19,648	113,416
L.P. Gas	12,545	101,208

c. Building Group Source Energy Consumption

Existing energy consumption of the various building groups at Fort Drum has been estimated on 14 representative building types. Table 1 lists these buildings and provides basic data. Energy consumption varies considerably for the different types of buildings due to the wide variations of occupancy. Some buildings are occupied year-round. Some are occupied three months per year in the winter. Others are occupied every other January with some occupied primarily during the summer months. Tables 2, 3, 4, and 5 provide estimates of energy consumption for the different occupancy classes.

FY78 ENERGY CONSUMPTION BY SOURCE
(545,245 MBTU)



**FY85 ENERGY CONSUMPTION BY SOURCE
(531,949 MBTU)**

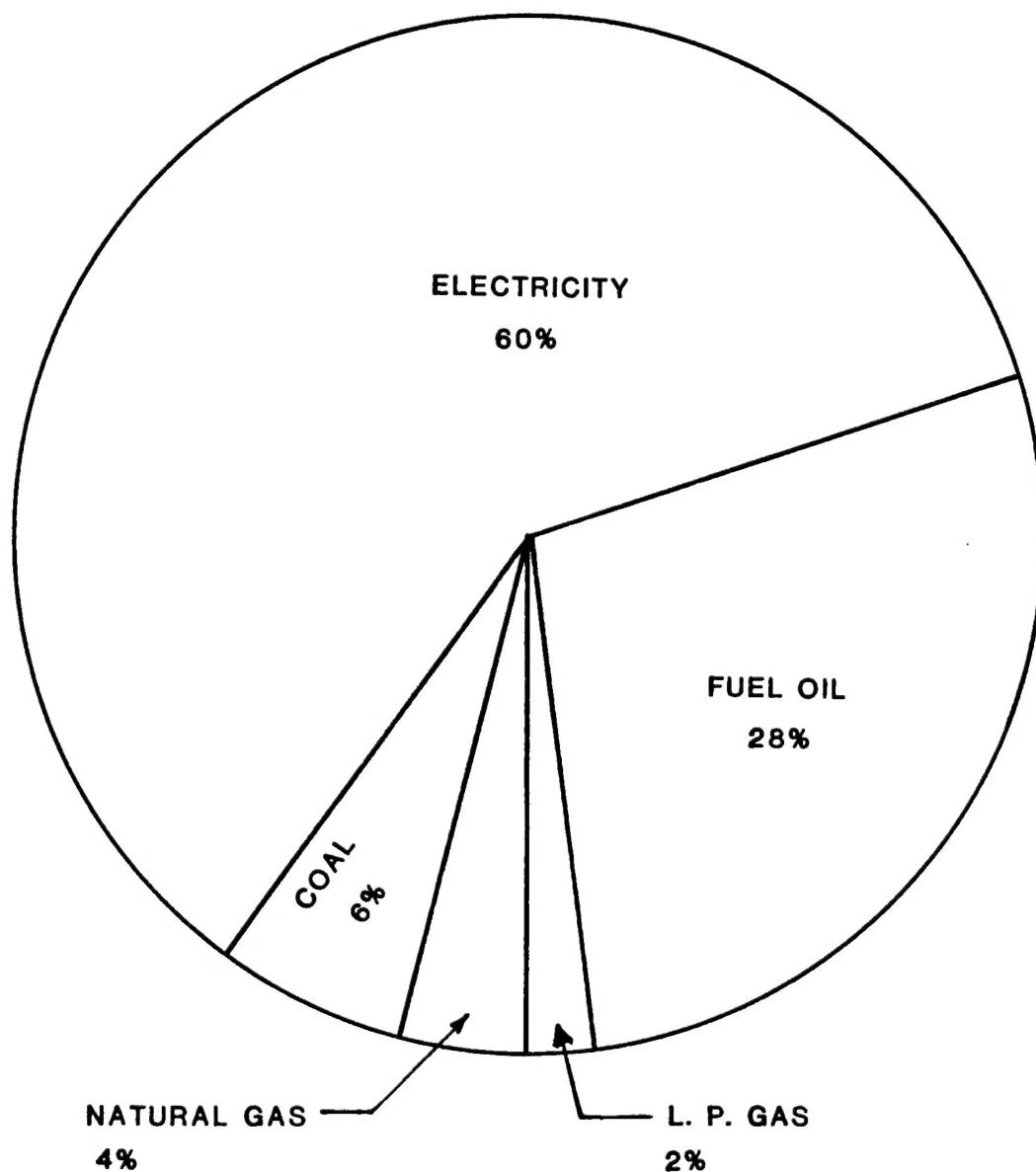


TABLE 1
CONSTRUCTION DATA

<u>Bldg.</u>	<u>Description</u>	Construction			<u>Window</u>	Window Floor			<u>Area: SF</u>	<u>Heating System</u>	<u>Fuel</u>	<u>Load MBH</u>	<u>Peak Trn.</u>	
		<u>Roof</u>	<u>Wall</u>	<u>Floor</u>		<u>Roof Wall</u>	<u>Floor Wind.</u>							
T-203	Administrative	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood v/alum. storm	.22	.21	.47	408	2,284	Furnace	011	119.7	
T-2208	Bachelor Officer's Quarters	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.20	.90	832	7,670	Furnace	011	250.6	
T-271	Barracks	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.21	.90	580	4,720	Furnace	Coal	178.6	
T-202	Chapel	Comp. Shingles	Steel on wood frame	Wood w/con. crawl	Wood: double hung	.27	.21	.90	438	3,537	Boiler	011	165.1	
T-682	Community Service	Comp. Shingles	Clapboard on frame	Wood w/wood skirt	Wood: double hung	.24	.19	.90	1,332	13,726	Boiler	011	551.9	
T-78	Exchange Facilities	Comp. Shingles	Steel on wood frame	Wood w/con. crawl	Wood v/alum. storm	.22	.22	.47	56	10,491	Furnace	011	419.8	
P-8039	Family Housing	Comp. Shingles	Clapboard on frame	Wood v/ basement	Thermopane	.05	.07	.55	118	9,805	Baseboard Elec.	80.1	Electric	
T-91	Maintenance	Comp. Shingles	Wood on wood frame	Slab on grade	Steel: casement	.09	.18	-	53	2,262	22,545	Boiler	011	390.0
T-2425	Medical	Comp. Shingles	Wood on wood frame	Wood w/wood skirt	Wood v/ plastic	.22	.21	.47	528	3,813	Furnace	011	196.0	
T-220	Hess Hall	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.21	.90	281	2,360	Stove	Coal	135.4	
P-1444	Motor Repair: Permanent	Metal	Steel on steel frame	Slab on grade	Metal: sliding	.09	.22	- 1.10	232	4,166	Furnace	011	145.5	
T-1242	Motor Repair: Temporary	Metal	Steel on steel frame	Slab on grade	Steel: projected	.30	.41	-	300	7,219	Furnace	Coal	299.1	
T-231	Recreation	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.21	.90	169	1,144	Furnace	011	71.0	
T-239	Storehouse	Comp. Shingles	Steel on wood frame	Slab on grade	Wood: double hung	.39	.32	- .90	192	2,588	Stove	Coal	129.5	

TABLE 2
ENERGY CONSUMPTION DATA FOR YEAR-ROUND OCCUPANCY

<u>Bldg.</u>	<u>Description</u>	Annual Source Energy				<u>Elec. Btu x 10⁶</u>	<u>kWh/Yr.</u>	<u>Btu x 10³</u>	<u>Ft.²</u>
		<u>Fuel</u>	<u>Cons. Btu x 10⁶</u>	<u>Elec.</u>	<u>Total</u>				
T-203	Administration	724	483	1,207		42,400		528	
T-2208	Bachelor Officer's Quarters	2,120	735	2,855		63,375		372	
T-271	Barracks	2,084	268	2,352		23,100		498	
T-202	Chapel	1,628	80	1,708		6,900		483	
T-682	Community Service	4,692	1,560	6,252		134,500		456	
T-78	Exchange Facilities	3,568	532	4,100		45,900		391	
P-8039	Family Housing	0	1,534	1,534		132,300		156	
T-91	Maintenance	3,780	2,573	6,353		221,800		282	
T-2425	Medical	1,292	437	1,729		37,700		453	
T-220	Mess Hall	1,693	483	2,176		41,700		922	
P-1444	Motor Repair: Permanent	772	681	1,453		58,700		349	
T-1242	Motor Repair: Temporary	2,231	263	2,494		22,700		346	
T-231	Recreation	425	139	564		12,000		493	
T-239	Storehouse	774	62	836		5,400		323	

TABLE 3
ENERGY CONSUMPTION DATA FOR
JANUARY, FEBRUARY, AND MARCH OCCUPANCY

<u>Bldg.</u>	<u>Description</u>	Annual Source Energy			<u>Elec. kWh/Yr.</u>	<u>Btu x 10³ Ft.²</u>
		<u>Fuel</u>	<u>Cons. Btu x 10⁶</u>	<u>Elec.</u>		
T-203	Administration	381	119	500	10,300	219
T-2208	Bachelor Officer's Quarters	1,034	181	1,215	15,600	158
T-271	Barracks	937	66	1,003	5,695	213
T-202	Chapel	826	20	846	1,800	239
T-682	Community Service	2,440	385	2,825	33,200	206
T-78	Exchange Facilities	1,831	131	1,962	11,300	187
P-8039	Family Housing	N/A	N/A	N/A	N/A	N/A
T-91	Maintenance	2,244	633	2,877	54,600	128
T-2425	Medical	664	108	772	9,300	202
T-220	Mess Hall	685	119	804	10,300	341
P-1444	Motor Repair: Permanent	449	168	617	14,500	148
T-1242	Motor Repair: Temporary	1,296	65	1,361	5,600	189
T-231	Recreation	222	34	256	3,000	224
T-239	Storehouse	448	15	463	1,300	174

TABLE 4
ENERGY CONSUMPTION DATA FOR JANUARY OCCUPANCY

<u>Bldg.</u>	<u>Description</u>	Annual Source Energy			<u>Elec. kWh</u>	<u>Btu x 10³ Ft.²</u>
		<u>Fuel</u>	<u>Cons. Btu x 10⁶</u>	<u>Elec.</u>		
T-203	Administration	141.6	41.7	283.3	3,600	124
T-2208	Bachelor Officer's Quarters	382.5	62.8	445.3	5,400	58
T-271	Barracks	344.3	22.9	367.2	2,000	78
T-202	Chapel	305.8	7.0	312.8	600	88
T-682	Community Service	906.3	132.2	1,038.5	11,400	76
T-78	Exchange Facilities	171.1	58.7	229.8	5,100	22
P-8039	Family Housing	N/A	N/A	N/A	N/A	N/A
T-91	Maintenance	858.6	223.8	1,082.4	19,300	48
T-2425	Medical	141.6	41.7	183.0	3,600	80
T-220	Mess Hall	250.8	41.0	291.8	3,500	124
P-1444	Motor Repair: Permanent	171.1	58.7	229.8	5,100	55
T-1242	Motor Repair: Temporary	493.2	22.7	515.9	2,000	72
T-231	Recreation	82.5	11.8	94.3	1,000	82
T-239	Storehouse	170.6	5.3	175.9	500	68

TABLE 5
ENERGY CONSUMPTION DATA FOR ONE SUMMER MONTH OCCUPANCY

<u>Bldg.</u>	<u>Description</u>	Annual Source Energy				<u>Elec. kWh</u>	<u>Btu x 10³ Ft.²</u>
		<u>Fuel</u>	<u>Cons. Btu x 10⁶</u>	<u>Elec.</u>	<u>Total</u>		
T-203	Administration	0	41.7	41.7	41.7	3,600	18
T-2208	Bachelor Officer's Quarters	24.2	62.8	87.0	87.0	5,400	11
T-271	Barracks	44.1	22.9	67.0	67.0	2,000	14
T-202	Chapel	0	7.0	7.0	7.0	600	2
T-682	Community Service	0.5	132.2	132.7	132.7	11,400	10
T-78	Exchange Facilities	0	58.7	58.7	58.7	5,100	6
P-8039	Family Housing	N/A	N/A	N/A	N/A	N/A	N/A
T-91	Maintenance	0	223.8	223.8	223.8	19,300	10
T-2425	Medical	38.3	37.1	75.4	75.4	3,200	20
T-220	Mess Hall	63.6	41.0	104.6	104.6	3,500	44
P-1444	Motor Repair: Permanent	0	58.7	58.7	58.7	5,000	14
T-1242	Motor Repair: Temporary	0	22.7	22.7	22.7	2,000	3
T-231	Recreation	0	11.8	11.8	11.8	1,000	10
T-239	Storehouse	0	5.3	5.3	5.3	500	2

C. ENERGY CONSERVATION MEASURES

1. ECM's investigated
 - o Building envelope improvements (weatherization)
 - o Building lighting improvements
 - o Street lighting
 - o F.M. radio control
 - o Solar energy
 - o Wind turbine generated electric power
 - o Central heating plants
 - o Flow control Shower Heads
 - o Toilet Tank Inserts
 - o Window Insulation
 - o Vestibules
 - o Building 2170 Boiler Replacement
 - o Insulate Cottages
 - o Reduce Hot Water Temperatures
 - o Insulate Ductwork in Mechanical Rooms
 - o Modification to Computer Room Cooling System
 - o Pipe Insulation for Mechanical Rooms
 - o Air Curtains
 - o Heat Recovery from Ice House Compressors
 - o Hot Water Tank Insulation
 - o Waste Oil as Fuel
 - o Peak Shaving Using Sewage Treatment Plan Emergency Generator
 - o Ceiling Fans
 - o Replacement of 1,000 Watt Mercury Vapor Floodlights with 400 Watt High Pressure Sodium on a Per Fixture Basis
 - o Replacement of Incandescent Lamps with 70 Watt High Pressure Sodium
 - o Replacement of 500 Watt Incandescent Lamps with 150 Watt High Pressure Sodium
 - o Relamp 100% Occupied Barracks with Incandescent Socket Type Fluorescent
 - o Reduction of Fluorescent Lighting Load
 - o Insulated Panels

- o Lower Space Temperatures
- o Add Heaters for Sedentary Areas in Industrial Buildings
- o Storm Sashes
- o Insulate Partitions Against Colder Spaces
- o Replace Oil Retrofitted Coal Furnaces
- o Replace Electric Heat with Oil Fired
- o Replace Sliding Warehouse Doors
- o Replace Electric Cooking Appliances
- o Insulate Heating Piping, Pumps, and Valves
- o Install Low Leakage Summer Ventilation Dampers
- o Kitchen Ventilation Automation
- o Heat Recovery from Kitchens, Flash Tank, and Commissary Compressors
- o Automatic Temperature Control Improvements
- o Replace Electric Boilers
- o Mechanical Equipment Optimization
- o Monitor Repairs of Utility Leaks, etc.

2. ECIP Project Developed

- a. T-072 Weatherization and lighting
- b. T-073 Weatherization and lighting
- c. T-096 F.M. control system
- d. T-097 weatherization and lighting
- e. Wood fired boiler plant

3. Other Energy Conservation Project Developed

a. Increment "G" Projects

<u>Project</u>	<u>Location(s)</u>
Flow Control Shower Heads	Family Housing
Insulate Ductwork in Mech. Room	165 Buildings
Reduce Water Temp.	231 Units
Modification to Computer Room	Building 55
Ceiling Fans	Building 2360
Water Tank Insulation	231 Buildings
Ceiling Fans	Building 682
Ceiling Fans	Bldgs. 91, 93
Insulate Cottages	Bldgs. 2253 thru 2258
Pipe Insulation	165 Buildings

<u>Project</u>	<u>Location(s)</u>
Ceiling fans	Warehouses
Replace incadescent w/150 watt HPS	Building 2360
Wdw. insulation	6 Buildings
Reduction of fluorescent light.	55 Buildings
Heat recovery from ice house	Building 60
Relamp barracks	14 Buildings
Ceiling fans	Building 84
Boiler replacement	Building 2170
Ceiling fans	Building 2059
Replace mercury with 400 watts HPS	Per item basis
Insulated Panels	Per sq. ft.
Vestibules	Barracks (49 bldg.'s)
Replace incandescents with 70 watt HPS	Building 84
Air curtain	Building 65
Toilet tank inserts	Family housing
Peak shavg. using gen. stp.	Sewage trtmt. plant

b. Increment "F" Projects

<u>Project</u>	<u>Location(s)</u>
Automate kitchen ventilation systems	Buildings 30 & 175
Install low leakage dampers in summer ventilation fans	Buildings 30 & 175
Water saving devices	Buildings 30, 175, 2166, & 36
Insulate heating piping	Buildings 175 and 2166
Weatherstrip doors	38 buildings
Reduce vent rate	Building 30
Equipment optimization	Buildings 60,36,2162,2222, & 1240
Insulate ductwork	12 buildings
Insulate walls, roofs, & floors	25 buildings
Insulate domestic water heaters	34 units
Remove windows & doors	14 buildings

Replace electric boilers with oil fired	Buildings 30 & 36
Reduce domestic hot water temperature	29 buildings
Add storm sashes	18 buildings
Replace electric cooking appliances with LPG units	Buildings 114, 175, & 30
Lower space temperature	13 buildings
Replace electric heat with oil fired	10 buildings
Ceiling fans	16 buildings
Lower temperature & add unit heaters	17 buildings
Insulate partitions	27 buildings
Replace sliding warehouse doors	5 buildings
Heat recovery systems	Building 175
Insulate domestic hot water piping	10 buildings
Build vestibules	Buildings 114, 115, & 73
Air curtains	Buildings 1174, 1030, & 4004

D. Results of Increment "A".

1. Scope: Energy conservation projects for buildings and processes including architectural systems, HVAC, plumbing and lighting.
2. Results: It is estimated that Increment "A" projects developed will save $77,154 \text{ btu} \times 10^6$ in source energy per year.
3. Recommendations: It is recommended that Weatherization and Lighting projects T-097, T-072, and T-073 be implemented.

E. Results of Increment "B".

1. Scope: Energy conservation investigations of utilities and energy distribution systems, Energy Monitoring and Control Systems (EMCS), and existing energy plants.
2. Results: It is estimated that the Increment "B" project will save $27,573 \text{ btu} \times 10^6$ in source energy per year.
3. Recommendations: It is recommended that project T-096 F.M. Control be implemented.

F. Results of Increment "C".

1. Scope: Renewable energy projects, principally solar and biomass.
2. Results: Solar energy and wind energy were studied for use at Fort Drum. Both solar and wind energy fail to meet Army economic criteria. The wind energy study prepared in 1981 was recently reviewed and given an economic simulation with current construction

2. (continued) - and electric power costs. The study reflected a savings to Investment Ratio (SIR) of less than 1.0.

3. Recommendation: The Increment "C" projects are not recommended.

G. Results of Increment "D".

1. Scope: Cogeneration and solid waste plants, utilizing solid fuels supplemented with refuse derived fuels and waste oil fuels.
2. Results: A central wood fired boiler plant with ability to accomodate waste oil was developed. This project was estimated to save $98,304 \text{ btu} \times 10^6$ in heating fuel by using wood chips. The wood fired plant project has been abandoned in favor of serving this load from another boiler plant planned for future growth at Fort Drum. The fuel will be coal.

H. Results of Increment "G".

1. Scope: Projects identified in Increments "A" and "B" that do not qualify under ECIP criteria.
2. Results: 26 energy conservation projects were developed under Increments "G". Estimated annual savings amounts to $25,916 \text{ btu} \times 10^6$.
3. Recommendations: It is recommended that the Increments "G" projects hereinbefore listed (by priority) be implemented.

I. Results of Increment "F".

1. Scope: Projects for modifications, repairs, and changes in system operation which are within the Facilities Engineer funding authority and management control.
2. Results: 26 projects are developed under the scope of Increment "F" which meet Army economic criteria. One of these projects includes minor repair work in 14 buildings that should be implemented by the DEH staff. Estimated annual savings amounts to $65,118 \text{ btu} \times 10^6$. Six additional projects are developed having SIR's less than 1.0.
3. Recommendations: Implement the 25 projects described hereinbefore and the one minor repair project. The six projects that currently do not meet the economic criteria should be reviewed at a later date as energy and construction costs change. Thirteen projects qualify for funding thru the PRODUCTIVITY CAPTIAL INVESTMENT PROGRAMS.

FIGURE NO. 1

SUMMARY OF INCREMENT A, B, & D PROJECTS

INCREMENT	PROJECT	LOCATIONS	ANNUAL ENERGY SAVINGS MBTU	E/C	PAYOUT PAYBACK YEARS
D	* CENTRAL WOOD FIRED BOILER PLANT		98,304	N/A	N/A
B	T096 FM CONTROL	0,100,200,500,600,800, 900,1000,1100,1300,1400, 1500,1600,2000,2100,2200, 2300,3800,4000, & 8000 AREAS	27,573	78.2	2.0
A	T097 WEATHERIZATION & LIGHTING	0,100,200,600,1000, 1100,2000,2100,2200,2300, 2400,3800, & 4000 AREAS	32,258	41.5	3.1
A	T072 WEATHERIZATION & LIGHTING	300 AREA	20,988	41.5	10.0
A	T073 WEATHERIZATION & LIGHTING	400 AREA	23,908	32.9	10.9

*This project has been abandoned in favor of a central coal fired boiler plant planned to serve future load.

FIGURE NO. 2

SUMMARY OF INCREMENT "G" PROJECTS

INCREMENT	PROJECT	LOCATIONS	ANNUAL ENERGY SAVINGS MBTU	E/C	PAYBACK YEARS
G	FLOW CONTROL SHOWER HEADS	FAMILY HOUSING	3,323	788	.2
G	INSULATE DUCTWORK IN MECH. ROOMS	165 BUILDINGS	9,702	292	0.4
G	REDUCE WATER TEMP.	231 UNITS	499	237	.5
G	MODIFICATION TO COMPUTER ROOM	BUILDING 55	552	182	1.4
G	CEILING FANS	BUILDING 2360	693	142	0.7
G	WATER TANK INSULATION	231 BUILDINGS	1,276	139	0.9
G	CEILING FANS	BUILDING 682	204	106	1.0
G	CEILING FANS	BUILDINGS 91, 93	546	73	1.4
G	INSULATE COTTAGES	BUILDING 2253 thru 2258	1,164	59	1.7
G	PIPE INSULATION	165 BUILDINGS	162	51	3.8
G	CEILING FANS	WAREHOUSES	1,019	49	2.0
G	REPLACE INCANDESCENT W/150 WATT HPS	BUILDING 2360	519	46	4.1
G	WDW. INSULATION	6 BUILDINGS	804	43	2.5

INCREMENT	PROJECT	LOCATIONS	ANNUAL ENERGY SAVINGS MBTU	E/C	PAYBACK YEARS
G	REDUCTION OF FLUORESCENT LIGHT	55 BUILDINGS	865	43	5.1
G	HEAT RECOVERY FROM ICE HOUSE	BUILDING 60	1,301	36	3.0
G	RELAMP BARRACKS	14 BUILDINGS	805	35	4.6
G	CEILING FANS	BUILDING 84	140	29	3.2
G	BOILER REPLACEMENT	BUILDING 2170	366	26	4.2
G	CEILING FANS	BUILDING 2059	469	26	2.6
G	REPLACE MERCURY WITH 400 WATTS HPS	PER ITEM BASIS	25	26	10.1
G	INSULATE PANELS	PER SQ. FT.	0.3	26	4.2
G	VESTIBULES	BARRACKS (49 BLDG. 'S)	1,223	22	5.0
G	REPLACE INCANDESCENTS WITH 70 WATT HPS	BUILDING 84	223	11	14.4
G	AIR CURTAIN	BUILDING 65	36	9	11.3
G	TOILET TANK INSERTS	FAMILY HOUSING	0	0	.5
G	PEAK SHAVG. USING GEN. STP.	SEWAGE TRTMT. PLANT	-1.2	-.05	4.5

FIGURE NO. 3

SUMMARY OF INCREMENT "F" PROJECTS

PROJECT	E.C.O. NO.	ANNUAL ENERGY SAVINGS MBTU	ANNUAL DOLLAR SAVINGS *	SIR	CONTRACT COST *	IN HOUSE COSTS		PAYBACK YEARS
						MATERIAL * \$	MAN HOURS	
AUTOMATE KITCHEN VENTILATION SYSTEMS	22	7,831	\$50,326	71.55	7,727	2,462	131 (ELECT. & PIPE FITTER)	0.15
INSTALL LOW LEAKAGE DAMPERS IN SUMMER VENTILATION FANS	21	7,105	\$49,566	30.8	18,303	9,217	186 (SH. MET. & ELECT.)	0.37
WATER SAVING DEVICES	20	2,279	\$24,504	20.04	12,794	6,032	113 (PLUMBER)	0.52
INSULATE HEATING PIPING	19	341	\$ 2,769	11.21	2,966	921	52 (INSUL.)	1.07
WEATHERSTRIP DOORS	4	1,530	\$11,520	10.92	12,404	2,422	299 (CARP.)	1.08
REDUCE VENT RATE	30	422	\$ 2,156	9.34	2,243	--	64 (A.C. MECH.)	1.04
EQUIPMENT OPTIMIZATION	24	3,322	\$20,999	7.14	30,110	16,637	252 (ELECT. & A.C. MECH.)	1.43
INSULATE DUCTWORK	8	1,772	\$14,389	6.67	25,890	3,567	612 (INSUL.)	1.8
LOWER SPACE TEMPERATURE **	1	2,566	\$19,138	5.59	39,900	21,337	335 (ELECT. & PIPE FITT.)	2.03

* MID 1987

** BUILDINGS IN PROJECT SHOULD BE ADDED TO F.M. CONTROL SYSTEM.

FIGURE NO. 3

SUMMARY OF INCREMENT "F" PROJECTS

PROJECT	E.C.O. NO.	ANNUAL ENERGY SAVINGS MBTU	ANNUAL DOLLAR SAVINGS *	SIR	CONTRACT COST *	IN HOUSE COSTS		PAYBACK YEARS
						* MATERIAL \$	* MAN HOURS	
INSULATE DOMESTIC WATER HEATERS	13	172	\$ 1,197	5.48	2,484	325	59 (INSUL.)	2.08
REPLACE ELECTRIC BOILERS WITH OIL FIRED	27	2,215	\$25,646	4.74	43,853	23,204	8 (BRICK L.)	1.71
REDUCE DOMESTIC HOT WATER TEMP.	11	112	\$ 690	4.68	1,586	--	397 (STM. FIT. & ELECT.)	2.30
INSULATE WALLS, ROOFS, & FLOORS	6	7,726	\$58,856	4.66	148,930	37,145	46 (PLUMB.)	2.53
REPLACE ELECTRIC COOKING APPLIANCES WITH LPG UNITS	18	14,091	\$76,844	4.50	126,441	89,893	321 (PLUMB.)	1.65
REPLACE ELECTRIC HEAT WITH OIL FIRED	15	5,337	\$45,977	3.56	97,049	42,684	1214 (ELECT. & HTG. MECH.)	2.11
REMOVE WINDOWS & DOORS	3	559	\$ 4,539	3.56	15,304	5,519	265 (CARP.)	3.37
CEILING FANS	10	797	\$ 6,169	3.27	24,832	8,058	415 (ELECT.)	4.03
ADD STORM SASHES	5	329	\$ 2,385	3.10	9,032	4,984	85 (CARP.)	3.79
LOWER TEMPERATURE & ADD UNIT HEATERS **	2	2,461	\$17,208	2.62	79,216	38,048	95 (CARP.)	4.60
							788 (HTG. MECH.)	

* MID 1987

** BUILDINGS IN PROJECT SHOULD BE ADDED TO F.M. CONTROL SYSTEM

FIGURE NO. 3

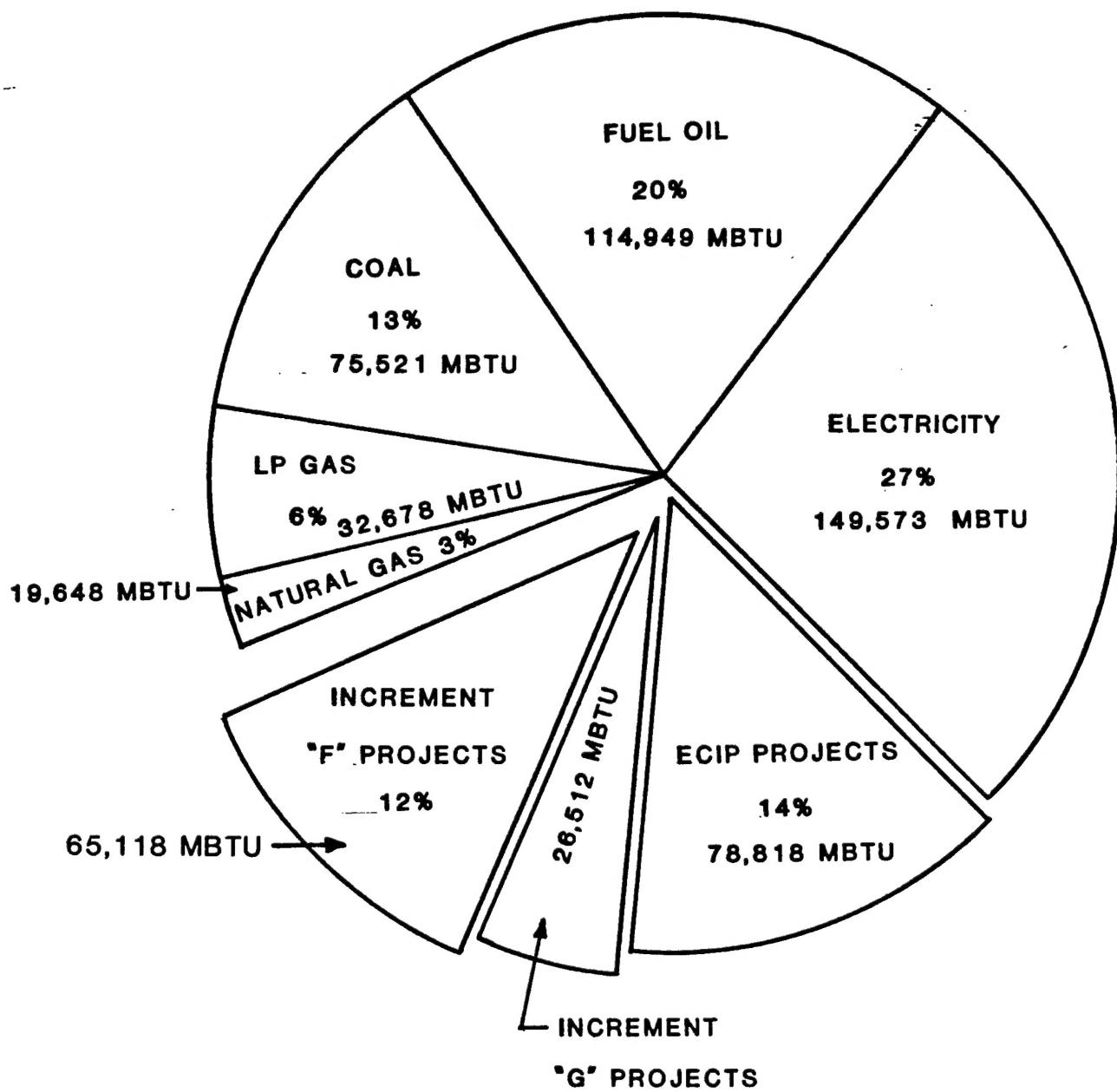
SUMMARY OF INCREMENT "F" PROJECTS

PROJECT	E.C.O. NO.	ANNUAL ENERGY SAVINGS MBTU	ANNUAL DOLLAR SAVINGS *	SIR	CONTRACT COST \$ *	IN HOUSE COSTS		PAYBACK YEARS
						* MATERIAL \$	MAN HOURS	
INSULATE PARTITIONS	7	879	\$ 6,451	2.11	35,429	3,452	998 (INSUL.)	5.49
REPLACE SLIDING WAREHOUSE DOORS	16	371	\$ 2,645	1.86	16,277	9,761	121 (CAR.)	6.15
HEAT RECOVERY SYSTEMS	23A	2,257	\$13,984	1.81	96,552	42,791	1191 (SHT. MET. & PIPE FIT.)	6.90
INSULATE DOMESTIC HOT WATER PIPING	12	7	\$ 36	1.44	241	58	6 (INSUL.)	6.69
BUILD VESTIBULES	17	175	\$ 1,421	1.29	13,166	7,001	135 (CARP.)	9.27
AIR CURTAINS	26	462	\$ 2,113	1.21	25,439	15,030	177 (ELECT.)	12.04

FIGURE NO. 3

PROJECT	E.C.O. NO.	SUMMARY OF INCREMENT "F" PROJECTS			CONTRACT COST \$ *	IN HOUSE COSTS * MATERIAL \$	MAN HOURS	PAYBACK YEARS
		ANNUAL ENERGY SAVINGS MBTU	ANNUAL DOLLAR SAVINGS *	SIR				
HEAT RECOVERY SYSTEMS	23B	2,031	\$10,193	0.99	110,826	56,094	1241 (A.C. MECH.)	10.9
REPLACE ORIGINAL COAL FIRED FURNACES WITH NEW OIL FIRED UNITS	14	751	\$ 6,098	0.95	77,090	56,563	131 (HTG. MECH.)	12.64
LIGHTING CHANGES UPGRADE FLUORESCENT FIXTURES	9B	1,814	\$12,068	0.91	113,064	44,133	1620 (ELECT.)	9.37
LIGHTING CHANGES REPLACE INCANDESCENT WITH HPS	9A	836	\$ 6,495	0.74	77,350	48,798	424 (ELECT.)	11.91
DEMAND LIMITING	28	DEMAND ONLY	\$ 3,393	0.41	75,092	42,993	573 (ELECT.)	22.13
AUTOMATIC CONTROL REVISIONS	29	1,057	\$ 1,609	0.22	144,992	80,432	1201 (A.C. MECH.)	90.11

PROJECTED ENERGY CONSUMPTION BY SOURCE
(392,369 MBTU)



NOTES:

5%

1. THE PERCENTAGE INDICATED BY EACH ENERGY SOURCE IS DERIVED FROM THE PROJECTED CONSUMPTION OF THAT FUEL TYPE DIVIDED BY THE TOTAL FY 78 ENERGY CONSUMPTION AND MULTIPLIED BY 100.
2. THE PERCENTAGE INDICATED BY EACH GROUP OF ENERGY CONSERVATION PROJECTS IS DERIVED FROM THE PROJECTED ENERGY SAVINGS DIVIDED BY THE TOTAL FY 78 ENERGY CONSUMPTION AND MULTIPLIED BY 100.
3. 545,245 MBTU ENERGY CONSUMPTION WAS DERIVED FROM THE EXECUTIVE SUMMARY FOR INCREMENTS A, B, C, D, & G PREPARED BY BLACK & VEATCH IN DECEMBER 1981. THE NATURAL GAS LOAD HAS BEEN ADDED SINCE 1978 AND SUMMED TO REFLECT A BASE LINE OF 564,893 MBTU. THE NATURAL GAS CONSUMPTION INDICATED IS FROM FY 85.
4. A PLANNED COAL FIRED CENTRAL BOILER PLANT IS EXPECTED TO REDUCE THE PROJECTED FUEL OIL CONSUMPTION BY APPROXIMATELY 98,000 MBTU.

J. Energy and Costs (FY 85 - unit energy costs).

1. Base-wide consumption and costs after energy conservation projects.

- a. Total : 392,369 MBTU, \$2,130,680
- b. Electricity : 149,573 MBTU, \$ 718,464
- c. Fuel oil : 114,949 MBTU, \$ 787,401
- d. Coal : 75,521 MBTU, \$ 249,975
- e. L.P. gas : 32,678 MBTU, \$ 261,424
- f. Natural gas : 19,648 MBTU, \$ 113,416

When the central coal fired boiler plant is constructed, the projected fuel oil consumption should be reduced by approximately 98,000 MBTU (from Black & Veatch Executive Summary, 1981).

This will reflect the following changes in base-wide consumption and costs:

- a. Total : 392,369 MBTU, \$1,783,760
- b. Electricity : 149,573 MBTU, \$ 718,464
- c. Fuel oil : 16,949 MBTU, \$ 116,101
- d. Coal : 173,521 MBTU, \$ 574,355
- e. L.P. gas : 32,678 MBTU, \$ 261,424
- f. Natural gas : 19,648 MBTU, \$ 113,416

K. Energy Conservation Measures Accomplished at the Installation

1. Since 1975 the following projects, modifications, or changes have been made or completed at the installation in order to conserve energy.

- a. PN 23 (ECIP): Insulate and weatherstrip 41 buildings.
- b. PN 22 (ECIP): Insulate, replace boilers T-91 and T-93.
- c. PN 69 (ECIP): Insulate floors, walls, ceiling, weatherstrip doors, windows, install storm windows, 53 buildingsl 100 Area.
- d. PN 44 (ECIP): Insulate floors, walls and ceilings, weatherstrip doors, windows, install storm windows, 91 buildings. 300/400 Area.
- e. Reduce domestic water temperature.
- f. Modify Computer Room, Building P55.
- g. Install ceiling fans, Buildings 2360 and 682.
- h. Construct vestibules, 49 barracks. (Being accomplished as buildings are rehabilitated).

- i. Water tank insulation.
- j. Replace incandescent lights in Building 2360.
- k. Window insulation.
- l. Install insulated panels.
- m. Replace incandescent fixtures with HPS in Building T-84.